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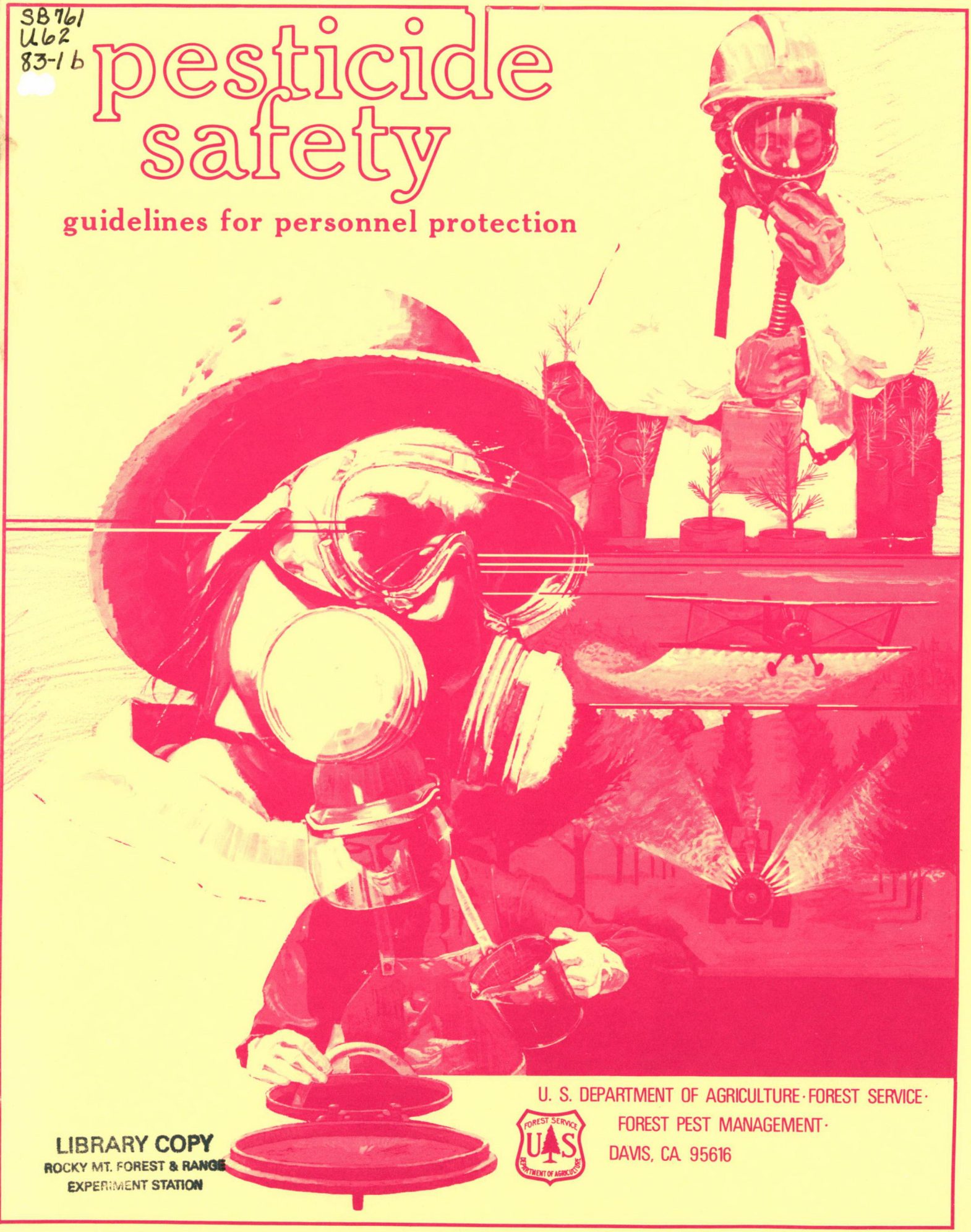
pesticide safety

guidelines for personnel protection



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FPM 83-1

PESTICIDE SAFETY

Guidelines for Personnel Protection

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August 1980

Revised October 1982

Reprinted February 1986

U.S. Department of Agriculture
Forest Service
Forest Pest Management/ WO
Davis, CA 95616

Under USDA Forest Service Contract
53-91S8-9-6257

Acknowledgments

This manual was prepared under U.S. Forest Service contract number 53-91S8-9-6257. Illustrations were prepared by Sally Hite. Wayne Handley, Steve Wilder, Bill Jukes, and Jack Ferdinand, of the California Agricultural Aircraft Association, reviewed the manuscript and provided helpful suggestions.

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Introduction

The safe use of pesticides requires conformance to instructions on the label of the pesticide container and common sense. Additionally, those applying pesticides must be familiar with the general field safety practices and Forest Service procedures as they have developed over the years.

Purpose

This publication provides information for the safe use of pesticides while they are being handled, stored, and applied in the field. The emphasis is on protecting personnel and should be referred to by project personnel during planning and conducting pesticide application projects.

Scope

These guidelines are applicable to Forest Service personnel involved in application of pesticides. Safe use and protection of personnel from the potential harmful effects of pesticides are of primary concern. The Forest Service places considerable importance on protecting personnel from any potentially harmful effects of pesticides.

References

The information provided in this publication is consistent with Title 2100, Chapter 2150, of the Forest Service Manual (FSM) and Forest Service Handbooks. It is based also on information from a variety of technical sources. (See Bibliography.) In the event that questions arise from the material presented here, the reader should refer to FSM 2150 as the final authority for pesticide-use management and coordination.

GENERAL RULES FOR PESTICIDE SAFETY

Each person involved in the handling of pesticides should have information on the safe use of the pesticides and be aware of the seriousness of allowing pesticides to be taken into the body by breathing, swallowing, or absorption through the skin or eyes. It is wise to assume that all pesticides may be absorbed through any one of these routes, and protective measures need to be strictly adhered to. This is the safe defensive approach. Knowledge of and planning for safe practices are fundamental to the protection of operating personnel, the public, and the environment.

Management Personnel

In every instance of pesticide application, someone must be responsible for the conduct of the operations. This management function includes insuring that:

- The application conforms to instructions on the product label.
- Application is within the rates specified on the label and that proper steps are taken to minimize off-target-area drift.
- Application equipment is regularly maintained, cleaned, and calibrated.
- All persons involved (including temporary personnel) are fully briefed on safe procedures, and are properly protected, supervised, and monitored.
- Liaison is pre-arranged with local medical facilities.
- Where required by law or determined necessary by medical advisors, personnel receive regular physical examination, including blood cholinesterase determinations.

Employees should never work alone with chemicals under conditions which would preclude prompt attention in case of an accident. Arrangements should be planned so that if an accident occurs it is possible to immediately:

- Decontaminate the individual.
- Provide emergency first aid.
- Provide follow-up medical care.

Arrangements for prompt treatment should be made in advance.

The most toxic compounds can be used safely if proper precautionary measures are observed. Proper instruction and training of personnel who handle pesticides is the most effective way to reduce hazards. It is fundamental that all workers be thoroughly informed on pesticide safety. This means that every person must be fully aware of the properties of the

chemicals in use, proper storage, handling, and disposal procedures, proper application practices, and the means of dealing with any emergency.

It should also be kept in mind, when training field staff, that industrial-type accidents are far more common on pesticide application projects than are pesticide poisoning accidents. Safe work practices during all tasks and phases of the project cannot be overemphasized.

Field Staff

It is suggested that the following information be prominently displayed where pesticide handlers are likely to congregate.

General rules for handling pesticides:

- Always wash immediately after handling pesticides, pesticide application equipment, or pesticide containers.
- Inspect pesticide containers for leaks before handling.
- Do not handle containers carelessly.
- Should leaks or spills occur, keep people and animals away; report immediately, contain the spill, and decontaminate thoroughly.
- Inspect vehicles for contamination after unloading; do not permit vehicles to leave the project area until decontaminated.
- Do not store pesticides or empty pesticide containers near feed, food, or drink.
- Do not keep food, drink, tobacco, cups, or eating utensils in pesticide work areas.
- Do not eat, drink, or smoke in pesticide work areas.
- Do not touch eyes or mouth while working with pesticides.
- Wash hands before eating, drinking, smoking, or using the toilet.
- Wear clean rubber gloves, an approved respirator when recommended, and other recommended protective clothing when handling pesticides.
- Do not use faulty protective clothing or equipment.
- Dispose of contaminated clothing or faulty protective gear in an approved manner if it cannot be thoroughly cleaned and repaired.
- Read pesticide labels carefully: if seeking medical aid, take the label for the physician's information.
- Insure that clean water and soap are available near pesticide work areas.

PLANNING IS THE KEY

The emphasis in this manual is on protecting personnel during pesticide applications. The first chapter raises issues to be considered in developing a safety plan. Subsequent chapters provide safety measures related to the various activities that occur during a pesticide application project — storing, handling, and mixing pesticides; applying them; cleaning up and disposal after application. The final two chapters provide information on recognizing symptoms of pesticide poisoning and providing first aid to victims of poisoning.

All of the chapters, however, have planning information. They should be reviewed when safety plans are being developed so that the safety plans will not overlook important precautions. Proper planning prevents poor safety performance.

Chapter 1:

Planning -- Safety Is No Accident

Projects involving the use of pesticides require extreme care in planning. Steps overlooked in this phase, that is, *before* there is any contact with the pesticides, may result in undue risk to personnel. Each pesticide project should have a safety plan. The person who will be responsible for preparing the safety plan and coordinating safety activities should be appointed early in the planning of the project. There are three sources of information for developing a safety plan: The Forest Service work plan, the pesticide label, and the Forest Service Manual.

The Work Plan

The work plan will contain information specific to the application project. This includes a description of the target area and pest; the pesticide to be applied and its toxicity; a description of the mixing and loading area; the method of application and equipment to be used; and the time schedule for the application.

The Label

The second important source of information is the label of the pesticide that will be used in the project. If a copy of the current label for the pesticide is not available, one can be obtained from the manufacturer or distributor. The label will include information on the toxicity of the pesticide; the protective clothing that is required when handling, mixing, and applying the pesticide; and the first aid and medical backup necessary in case of an accident. (For a discussion of label information, see "Pesticide Labels", page 9.)

Forest Service Regulations

The third source of information is FSM 2150, "Pesticide-Use Management and Coordination" and its companion handbook FSH 2109.11. Subsection 2153.22 discusses project safety plans. Sections of particular interest include 2156, "Safety in Pesticide Use"; 2157, "Pesticide Transporation, Storage, and Disposal"; and 2158, "Forms, Reports, and Publications."

SAFETY SUPERVISION

Forest Service regulations specify that the project director is ultimately responsible for ensuring the safety of project personnel. Because of the many duties of the project director during pesticide applications, however, the project director may designate one or more safety officers to prepare the safety plan and monitor the handling of the pesticides at each mixing site identified in the work plan.

Responsibilities and Authorities

During the use of pesticides—including transportation, storage, mixing, loading, application, and cleaning up—the project safety officer will monitor the handling of the chemicals. In addition, the project safety officer is responsible for informing and training all personnel, as required, in the safety procedures to be followed. The safety plan should spell out these authorities and procedures.

Contractor Relations

If nongovernment contractors are to be used in applying pesticides, the project director, assisted by the safety officer, is responsible for ensuring that the contractor's personnel are knowledgeable of and adhere to Forest Service directives in performing their work. The project safety plan should specify how this is to be accomplished.

Medical Backup

Each pesticide-use project must have appropriate medical backup included in the safety plan. This may require that a nearby physician be contacted, told of the chemicals to be used, and a plan for treatment of accident victims be agreed upon. The name, telephone number, and location of the physician should be posted at each project site where exposure could occur.

INFORMATION AND EDUCATION

The safety plan should note that an information and education plan has been developed to inform the public about the treatment area. There are two measures that should be taken to notify the public. First, local radio stations and newspapers should be encouraged to give their listeners and readers notice before the application and on the day of application. Second, the area to be treated may have to be posted with warning signs. It may also be necessary to develop plans with local authorities for detouring traffic away from the target and staging areas and otherwise prevent access.

PERSONNEL SAFETY

Personnel safety is the largest component of the safety plan. During the plan development phase, it requires obtaining and analyzing information on the target area, application plan, and pesticide to be used. At the beginning of the field phase, personnel should be trained in the precautions set forth in the plan, and during the field phase and post-application phase, personnel should be monitored for conformance to the safety plan stipulations.

The following checklist provides a sequence of concerns that the project safety officer should keep in mind when developing the safety plan.

- Planning Phase. Information should be obtained and analyzed on:
  - Target area to be treated.
  - Pesticides to be used, including toxicity category, formulation, toxicology, and special recommendations for protective equipment and clean-up procedures.
  - Site of the staging area, including storage facilities and security.
  - Application method, including the system to be employed and any special safety aspects related to the equipment.
  - The time schedule for the application.
  - Protective equipiment and methods, particularly those recommended by the pesticide manufacturer and those described elsewhere in this publication.
  - Emergency procedures to be followed in the event of a spill or accident involving the selected pesticide.
- Field Phase. Plans should be developed that will specify the following:
  - How personnel will be trained in the specific safety aspects for the pesticide application.
  - Rules that will apply to the mixing and loading site and to personnel working in that area, including how pesticides will be stored and secured and how storage areas will be posted.
  - How personnel will be monitored for safety compliance and symptoms of exposure.
  - What protective clothing will be worn and by which personnel, including storing and cleaning of the clothing between work periods.
- Post-application Phase. Plans should be developed to cover winding up the operation; these include:
  - A plan for disposal of unused pesticides and empty containers.
  - Methods to be used for decontamination and cleaning of equipment.
  - How protective clothing will be cleaned or disposed of.

The remaining chapters in this publication provide general information on pesticides and safety procedures for protecting personnel from accidental exposure. It is important to repeat, however, that the pesticide label should be the final authority regarding special precautions to be observed in the application of any particular product.

Chapter 2:

Know The Pesticides

Pesticides are chemicals that control, prevent, destroy, repel, or regulate forms of life that are pests. Insecticides, herbicides, fungicides, and rodenticides are the kinds of pesticides most frequently used by the Forest Service; they are not limited to any particular kind of substance and they vary in their hazard to humans.

PESTICIDES USED IN FORESTRY

There are six types of pesticides most frequently used in forestry management; they are fumigants, fungicides, herbicides, insecticides, repellents, and rodenticides.

Fumigants

Fumigants are used to sterilize soil in seed and plant beds, usually in nursery operations. They are also used to protect seeds against certain kinds of pest infestations. Fumigants are volatile liquids, gases, or granules.

Fungicides

Fungicides are used to control fungi and molds that cause root rot in plants and attack wooden structures. They are usually liquids, wettable powders, or granules.

Herbicides

Herbicides are used to suppress unwanted plants. They are usually liquids, but may also be granules or wettable powders.

Insecticides

Insecticides are substances that kill or control insects. They are applied in a variety of forms—liquid, dust, and granule.

Repellents

While most pesticides aim at killing or controlling a target pest, repellents aim at simply keeping pests away from plants or animals that need protection. Most repellents are liquids.

Rodenticides

Rodenticides are poisons used to control mice, rats, rabbits, and other rodents. They are usually baits of grain or dried fruit mixed with a poison.

PESTICIDE LABELS

Before pesticides can be used, they must be registered with the U.S. Environmental Protection Agency under provisions of the Federal Insecticide Fungicide and Rodenticide Act (FIFRA), as amended. To comply with the requirements of FIFRA, the labels on the pesticide containers must include certain critical information and are legal documents that must be followed by anyone using the pesticide. There are both civil and criminal penalties for using a pesticide in a manner that does not conform with label statements.

The importance of the information on the label cannot be stressed too strongly. The information was put there to protect personnel and the environment. If the label is read and understood, and its directions followed, the likelihood of causing an accidental poisoning or contamination of the environment is lessened considerably. The label should be read each time a pesticide is used, even though the person using it may be familiar with the chemical.

There are at least four times the label should be read:

- ***Before developing the safety plan for the pesticide project.*** The label will provide most of the information needed to properly prepare the safety plan, order the necessary safety equipment, and instruct personnel about safety.
- ***Before the pesticide is stored.*** The label will describe how to store the pesticide correctly. Generally, pesticides should never be stored with food or feed, or where they may be contaminated by other pesticides; the label will indicate if there are special storage precautions to follow.
- ***Before the pesticide is mixed.*** The label includes directions for mixing the pesticide, including how much to mix, what protective clothing and equipment is required, and what first aid procedures may be required in case of accidental exposure.

- ***Before disposal of unwanted pesticides or empty containers.*** The label will include instructions for proper disposal procedures to avoid health risks or unwanted environmental contamination.

Pesticide labels conform to a set of standards. Each registered label is required by the FIFRA to have specific information and must contain at least the following:

- Brand, trade, or manufacturer's name of the product. An example of a brand name might be BUG KILL or WEED KILL. This name is usually the largest and most conspicuous wording on the label.
- Common or generic name. Most pesticides have an official common name for the active, or toxic, chemical ingedient. This is a generic name; it will be found on the label of any brand-name pesticide that contains it.
- Type of formulation. The formulation of the pesticide is the mixture of the active ingredient with inert ingredients.
- Ingredient statement. All of the active, or toxic, ingredients in a pesticide formulation must be listed on the label. These are listed as percentages by weight. Inert ingredients are not required to be listed by chemical name if the label shows what percentage of the total material is inert.
- Net contents. The label will specify how much material is in the container.
- Name and address of manufacturer. Each pesticide label must include the name of the company that manufactured and distributed the pesticide.
- EPA registration number and establishment number. The registration number on the label indicates that the product has been registered with the U.S. Environmental Protection Agency. The establishment number identifies the facility at which the pesticide was made.
- Statement of use classification. Registered pesticides are classified for either general or restricted use. General-use pesticides are the least hazardous and provide little danger when used in accordance with the label directions. Also, they can be applied by any competent applicator. Restricted-use pesticides are those that may be hazardous to the environment, the applicator, or the other persons, even when label directions are followed. Restricted-use pesticides can be applied only by certified applicators.
- Signal words and symbols. The hazard to humans is indicated on the label by signal words. The words "DANGER-POISON," and the skull and crossbones are required on the labels of all highly toxic compounds. The word "WARNING" is required on the labels of all moderately toxic compounds. The word "CAUTION" is required on the labels of all slightly toxic compounds. The words "Keep out of reach of children," are required on all labbels. (See figures 2-1, 2-2 and 2-3.
- Precautionary statement. The label contains a precautionary statement that sets forth any special hazards in using the chemical. It may, for example, indicate that the product poses a special danger if inhaled, that it may adversely affect the environment, or that it is highly combustible. Usually, the precautionary statement will also indicate specific precautions against the special dangers. For example, it may direct personnel to use approved respirators, or avoid using it near streams, or mix the chemical only in a fire-safe location. If the product is highly toxic, this section will inform physicians of the proper treatment for poisoning.
- First aid. The label will state what first aid measures to take in the event that a person is accidentally exposed to the pesticide. The label will also indicate when to seek medical attention in the event of exposure.
- Directions for use. The directions for use contain information about how to mix and apply the pesticide; the particular pest or

Fig. 2-1

BRAND NAME

GENERIC NAME

DANGER—POISON

ACTIVE INGREDIENT: _____
INERT INGREDIENT: _____
TOTAL: _____ 100

MANUFACTURED BY: _____
TOWN, STATE: _____
ESTABLISHMENT NO: _____
E.P.A. REGISTRATION NO: _____

THIS PRODUCT CONTAINS X LBS. PER GALLON

RESTRICTED USE PESTICIDE
MAY BE APPLIED ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION

FIRST-AID TREATMENT
IF INHALED _____
IF SWALLOWED _____
IF IN EYES _____
IF ON SKIN _____

DIRECTIONS FOR USE
THIS PESTICIDE MAY NOT BE USED IN A MANNER FOR WHICH IT WAS NOT REGISTERED

PRECAUTIONARY STATEMENTS
SPECIAL HAZARDS TO HUMANS AND DOMESTIC ANIMALS _____

RESTRICTIVE STATEMENT

STORAGE AND DISPOSAL
STORAGE _____
DISPOSAL _____
RE-ENTRY INFORMATION _____
RESIDUES _____

KEEP OUT OF REACH OF CHILDREN

NET CONTENTS _____

Fig. 2-2

BRAND NAME

GENERIC NAME

WARNING

KEEP OUT OF REACH OF CHILDREN

ACTIVE INGREDIENT: _____
INERT INGREDIENT: _____
TOTAL: _____ 100

MANUFACTURED BY: _____
TOWN, STATE: _____
ESTABLISHMENT NO: _____
E.P.A. REGISTRATION NO: _____

THIS PRODUCT CONTAINS X LBS. PER GALLON

FIRST-AID TREATMENT
IF INHALED _____
IF SWALLOWED _____
IF IN EYES _____
IF ON SKIN _____

DIRECTIONS FOR USE
THIS PESTICIDE MAY NOT BE USED IN A MANNER FOR WHICH IT WAS NOT REGISTERED

PRECAUTIONARY STATEMENTS
SPECIAL HAZARDS TO HUMANS AND DOMESTIC ANIMALS _____

RESTRICTIVE STATEMENT

STORAGE AND DISPOSAL
STORAGE _____
DISPOSAL _____
RE-ENTRY INFORMATION _____
RESIDUES _____

NET CONTENTS _____

Fig. 2-3

BRAND NAME

GENERIC NAME

CAUTION

KEEP OUT OF REACH OF CHILDREN

ACTIVE INGREDIENT _____
INERT INGREDIENT _____
TOTAL: _____ 100

MANUFACTURED BY _____
TOWN, STATE: _____
ESTABLISHMENT NO: _____
E.P.A. REGISTRATION NO: _____

THIS PRODUCT CONTAINS X LBS. PER GALLON

FIRST-AID TREATMENT
IF INHALED _____
IF SWALLOWED _____
IF IN EYES _____
IF ON SKIN _____

DIRECTIONS FOR USE
THIS PESTICIDE MAY NOT BE USED IN A MANNER FOR WHICH IT WAS NOT REGISTERED

PRECAUTIONARY STATEMENTS
SPECIAL HAZARDS TO HUMANS AND DOMESTIC ANIMALS _____

RESTRICTIVE STATEMENT

STORAGE AND DISPOSAL
STORAGE _____
DISPOSAL _____
RE-ENTRY INFORMATION _____
RESIDUES _____

NET CONTENTS _____

pests it is registered for; where, when, and how much to apply; and how often to apply the material.

- Misuse statement. The label will warn that the pesticide may not be used in a manner for which it is not registered.
- Re-entry information. Some pesticides present a hazard to persons who enter treated areas before the chemical has had time to degrade. If necessary for the product, the label will specify a period of time after application before the treated area should be entered without protective clothing.
- Storage and disposal directions. This section will tell how to store and dispose of the pesticide and empty containers.
- Residues. If the pesticides is used on food, feed, or livestock, the label may specify an interval between final application and harvest or slaughter. This interval is to allow harmful pesticide residues to degrade to acceptable levels before the product is consumed.
- Restrictive statement. Depending on the uses for which the pesticide is registered, the label may contain a restrictive statement, such as "Do not feed straw or crop residues to livestock."

CLASSIFICATION BY TOXICITY

Most chemicals in sufficient amounts are toxic to humans — they differ only in degree. For comparison, the following table shows the relative toxicity of four common household chemicals. The categories of toxicity shown in the table are the same as those used to classify pesticides later in this section.

How Pesticides Affect Humans

Before classifying pesticides, however, it is useful to know how they affect humans. Pesticides can enter the body in solid, liquid, or gaseous form. Highly concentrated and highly toxic chemicals, especially liquids and gases, present the greatest danger. If they are not removed immediately, the liquid concentrates can readily penetrate the skin. The longer a pesticide remains on the skin or in the eyes, or the longer it is inhaled, the greater the damage that is likely to result.

There are four common ways that pesticides enter the human body: Through the skin, the mouth, the lungs, and the eyes.

Dermal exposure. Absorption through the skin is the most common route of poisoning resulting from exposure to pesticides. Absorption may occur as a result of a splash, spill, or drifting mist when handling the pesticide during mixing, loading, application, or disposal. The degree of hazard from dermal absorption depends on the dermal toxicity of the pesticide, the extent of the exposure, the pesticide formulation, and the site of contamination. In general, wettable powders, dusts, and granular pesticides are not as readily absorbed through the skin and other body tissues as are the liquid formulations. Certain organs and tissues of the body—eyes, genitals, mucous membranes—

Common Chemicals	Oral Toxicity	Approximate Amount Needed to Kill the Average Adult
Laundry bleach tablets	Category I: Very high toxicity	Taste to a teaspoonful
Rubber cement	Category II: High toxicity	Teaspoonful to a tablespoonful
Liquid detergent	Category III: Moderate toxicity	Ounce to a pint
Baby lotion	Category IV: Low toxicity	Pint to a quart or more

absorb pesticides thoroughly and rapidly.

Oral exposure. If a pesticide is taken into the mouth, it can cause serious illness, severe injury, or death. The most frequent cases of accidental oral exposure happen when pesticides are taken from their original, labeled container, illegally put into an unlabeled bottle or food container, and mistakenly consumed.

Respiratory exposure. Inhalation of pesticides can cause serious damage to nose, throat, and lung tissues. The potential hazard of respiratory exposure is great, because pesticides are readily absorbed by these tissues. Vapors and extremely fine particles represent the most serious potential for respiratory exposure.

Eye exposure. The tissues of the eye are particularly absorbent and, therefore, getting some pesticide products in the eye can present an immediate threat of loss of sight, illness, or death. Eye protection is needed when measuring or mixing concentrated highly toxic pesticides; protection is also needed when there is a risk of exposure to dilute spray or dust drifts.

Acute and Chronic Exposure

There are two types of exposure—acute and chronic. When a single dose of a pesticide is administered, or when a single exposure to a pesticide occurs, it is called an "acute" exposure. Thus, acute dermal refers to a single dose applied to the skin; acute oral refers to a single dose taken by mouth; and acute inhalation refers to a single dose that is inhaled. When there is repeated or continuous exposure to a pesticide, it is called "chronic" exposure; chronic toxicity can be described, also, by type of exposure—chronic dermal, chronic oral, or chronic inhalation.

LD_{50} and LC_{50}

To understand how toxic some chemicals are, and the differences in acute toxicity among chemicals, it helps to know how toxicity is determined and rated. When a pesticide is applied on test animals, the amount of chemical that will kill one half, or 50 percent, of the animals tested is referred to as the "lethal dose to 50 percent," or LD_{50}. LD_{50} is the standard measure of toxicity of the active chemicals used in pesticide formulations. When the material is tested by applying it to the skin of the animals, the result is referred to as "Dermal LD_{50}"; when the chemical is tested by feeding it to the animals, the result is referred to as "Oral LD_{50}."

Pesticides are often toxic when they are inhaled by terrestrial or aquatic organisms. To measure the toxicity of chemicals in air or water, the material is mixed with air or water and the test animals intake the chemical. When the concentration of chemical kills 50 percent of the test population, the amount is referred to as the "lethal concentration to 50 percent," or LC_{50}.

Categories of Pesticide Toxicity

The active ingredients in pesticides are assigned toxicity categories on the basis of their LD_{50} or LC_{50} ratings; the categories range from Category I, the most toxic, to Category IV, the least toxic. Following are examples of active ingredients used in forestry for each category.

Caution should be undertaken in using these lists, however. Many active ingredients vary in toxicity depending on their formulation or when combined with other active ingredients. While the following lists place the active ingredients in the highest category *likely* to be encountered in forest management, *the specific product label must be checked to determine the correct toxicity category for the particular product.*

Category I pesticides. The labels of these pesticides carry the words DANGER-POISON in large, bold letters and a skull and crossbones. They are the most hazardous pesticides used in forestry.

- Arsenic salts
- Azinphos-methyl
- Bifenox
- Carbofuran
- Methyl bromide
- Permethrin
- Prometon
- Sodium chlorate

- Chloropicrin
- Chlorothalonil
- Endothall
- Ethylene dibromide (EDB)
- Sodium cyanide
- Strychnine
- Zinc phosphide

Category II pesticides. The labels of these pesticides carry the word WARNING in large, bold letters. They are less dangerous than Category I pesticides, but are nevertheless hazardous.

- Bromacil
- Chlorpyrifos
- Coumaphos
- Diazinon
- Dimethoate
- Diquat
- Fenitrothion
- Glyphosate
- Hexazinone
- Lindane
- Oxyfluorfen
- Pentachlorophenol
- Picloram
- Simazine
- Toxaphene
- Triadimefon
- Trifluralin
- Vorlex

Category III pesticides. The labels of these pesticides carry the word CAUTION in large, bold letters. These chemicals are less dangerous than either Category I or Category II chemicals, but are sufficiently hazardous to be treated with respect.

- Acephate
- Amdro
- Ammonium sulfamate
- Atrazine
- Cacodylic acid
- Carbaryl
- Dalapon
- Dazomet
- DCPA
- Dicamba
- Dichlobenil
- Diphacinone
- Diphenamid
- Diuron
- DSMA
- EPTC
- Hexazinone
- Linuron
- Malathion
- MCPA
- MCPP
- MSMA
- Rotenone
- TCA
- Tebuthiuron
- Thiram
- Triclopyr
- 2,4-D
- Vernolate

Category IV pesticides. These pesticides, whose labels also carry the word CAUTION in large, bold letters, present minimal or virtually no hazard to humans when handled intelligently.

- Amitrole
- Asulam
- Bacillus thuringiensis
- Benomyl
- Bifenox
- Captan
- Chloramben
- Ferbam
- Fosamine ammonium
- Maleic hydrazide
- Maneb
- Methoxychlor
- Napropamide
- Oryzalin
- 2,4-D
- Zineb

CLASSIFICATION BY CHEMICAL GROUP

Pesticides, as purchased, have two kinds of ingredients—active ingredients, which are the poisons, and inert ingredients, which are added to the active ingredients to make them convenient to handle, and easy and accurate to apply. Most active ingredients are organic compounds.

Organic compounds are those which contain carbon atoms in their chemical structure. Most organic compounds are synthesized or manufactured from basic chemical components, but some, called botanicals, are extracted from plants. Organic compounds used for pest control are members of various groups of chemicals. Each group contains chemical compounds that have some common characteristics, and any one group may contain insecticides, herbicides, and fungicides. The groups of organic chemicals typically used in forestry are as follows:

Chlorinated Hydrocarbons

All pesticides in this group contain chlorine, carbon, and hydrogen; some also contain oxygen and sulphur. Many of these compounds have relatively high persistence and tend to accumulate in the fatty tissues of man and animals. The best known members of this group are chlordane, lindane, toxaphene, and endosulfan. Others, such as dicofol, contain oxygen. (There are other chlorinated compounds which are placed in different groups because of special features of their chemical structure.)

Organophosphates

Most organophosphates are derivatives of phosphoric acid. They contain phosphorus, carbon, and hydrogen; some also contain nitrogen, oxygen, and, frequently, sulphur. Many members of the group have a high acute toxicity, and all act as cholinesterase depressants. Most of the group are insecticides. Many are combustible. Common members of the group are malathion and diazinon.

Carbamates

This group of compounds is typified by a particular arrangement of nitrogen, carbon, and oxygen in the chemical structure. Members of the group are carbaryl, methomyl, and maneb—all insecticides.

The toxic hazard to humans from this group is mild generally, but some have high acute toxicity.

Chlorophenoxys

The chemical structure of this group is characterized by a phenol ring to which is attached a number of chlorine atoms and a variety of organic acids. Virtually all are herbicides, and members of this group are among the most widely used herbicides. The most common members of the group are 2,4-D and MCPA. All have low to moderate toxicity to humans; some formulations, however, are sufficiently volatile to cause phytotoxic risk by vapor drift.

Dinitrophenols

Dinitrophenols belong to a family of dye chemicals. They are yellow and stain any organic material they come in contact with. This group is considered to be quite toxic; they may be used as herbicides or insecticides.

Substituted Ureas

This group of herbicides is mildly toxic to humans; it includes fenuron, monoron, an diuron. The earliest compounds in this group were non-selective, long-term residual weed killers, usually applied to the soil. More recently developed compounds, such as linuron, are more selective.

Triazines

The chemical compounds in this group are related to the substituted ureas. They are all herbicides of mild toxicity to humans. They include atrazine, simazine, propazine, prometon, and amitrole.

Botanicals

Compounds of this group are derived from plant materials rather than synthesized. Members of the group includes pyrethrins, rotenone (derris), ryania, and nicotine. Toxicity to humans ranges from very low for pyrethrins to very high for nicotine sulphate.

Guanidines and Napthoquinones

This group has low toxicity to humans and includes fungicides dodine and dichlone; chemicals in this group are not generally used in forestry.

Dihalobenzoic, Trichlorobenzoic, Trichloroacetate, and Trichloropicolinic Acids

This group of herbicides, is relatively nontoxic to humans and includes TCA and picloram. TCA, however, will cause burns from prolonged skin contact, and picloram is combustible. All are herbicides.

Cyclohexenes, Phthalimides, and Propionics

This group includes captan (fungicide) and dalapon (herbicide). All are mildly toxic to humans.

Dipyridyls

Chemicals in this group are herbicides and include diquat and paraquat. Both diquat and paraquat are liquid herbicides; they are considered very toxic to humans.

Hydrophthalics

This group is very toxic to humans and includes endothall, a herbicide mainly used for aquatic weed control.

Benzothiazoles

Benzothiazoles are derivatives of thiocyanic acid. They are heterocyclics possessing a particular arrangement of nitrogen, carbon and sulphur atoms. They are not generally used in forestry.

Organotins

These compounds are used in agriculture and industry as fungicides, algicides, slimicides, and disinfectants. They are rarely used in forestry.

Inorganic Compounds

Inorganic compounds do not contain carbon, and are usually derived from mineral ores. Inorganic pest control chemicals are among the oldest known pesticides, and include herbicides, fungicides, insecticides, and rodenticides. The inorganic compounds most commonly used today are derived from copper or sulfur. Compounds of arsenic, lead, and mercury have been widely used in the past.

CLASSIFICATION BY FORMULATION

Pesticides are available in a variety of forms. Active chemicals are usually in a form that is not suitable for direct application and may require alteration by mixing with liquid or dry diluents, grinding, or addition of emulsifiers, stabilizers, or other substances. The product that results is known as the formulation. It is the formulated product that is put into the spray tank and mixed with water or oil. The most common types of formulations are discussed below. Note that their abbreviations are also given; some pesticide labels refer to formulations by these abbreviations.

Aerosols, A.

Aerosols are liquids applied in a spray of fine droplets that contain a small amount of pesticide. The spray is driven through a small nozzle under pressure by either an inert gas or compressed air.

Baits, B.

Baits are mixtures of active ingredients in pest foods or attractants. They are usually intended for direct application without further dilutions.

Dusts, D.

Pesticides prepared as dusts consist of a finely ground carrier material, such as talc, mixed with the active ingredient. Dust formulations are always used dry and are intended for direct application without further mixing. Dusts present a drift hazard.

Emulsifiable Concentrates, EC or E.

Some chemicals are insoluble in water; by dissolving the active material in a petroleum-based solvent, a concentrated liquid is formed. An added emulsifying agent allows the pesticide to be further diluted with water for application.

Encapsulated Material.

The active ingredient is encased in an inert material for a slow, sustained release of pesticide. The advantage of encapsulated materials is decreased hazard in handling and application.

Flowables, F or L.

The flowables are liquid pesticides that are usually mixed with water for use in a sprayer. They form suspensions in water and require continual agitation.

Fumigants

These are volatile chemicals that are liquid when stored under pressure and become gases when released. They are used in confined spaces or in soil.

Granules, G.

In a granulated formulation, the active ingredient is mixed with an inert carrier to form particles that may range in size from table salt to golf balls. Granular formulations are intended for direct application without further dilution, and should not be mixed with water. They may be applied from the air when drift of other formulations may be a problem.

Soluble Powders, SP.

These powders are similar to wettable powders, except that the active ingredients, as well as the diluent and formulating ingredients,

will completely dissolve in water. Agitation may be needed, however, to get them to dissolve initially.

Ultra-Low Volume, ULV.

This highly concentrated solution may contain the active ingredient alone; it is applied without diluting. These solutions require special equipment to apply them at ultra low volumes while maintaining a fine droplet spray.

Water-Soluble Concentrates.

These liquid formulations form true solutions in water and require no agitation once mixed.

Wettable Powders, WP or W.

These dispersible powders are finely ground, dry powders consisting of active and other ingredients. The wettable powders are intended for dispersion or suspension in a liquid (usually water) for application by spray equipment. They are generally mixed with water to form a slurry before being added to the mix tank. They require agitation during application.

Chapter 3:
Field Precautions -- Storing, Handling, Mixing

Pesticides can poison people, pets, and livestock; they can damage beneficial insects, birds, fish, and other wildlife; and they can harm desirable plants. It is necessary to maintain careful and continuous control over the use and handling of these chemicals during storage, transport, mixing and loading, application, and disposal. Care and judgment must be exercised during all situations involving pesticides. Additionally, special procedures are necessary should pesticides be spilled or catch fire.

STORING PESTICIDES

Pesticides should be stored in a safe, secure, and well-identified place. While the label gives precise storage information for the particular pesticide, general rules are as follows:

- Pesticides should be stored in the original, labeled container with the label clearly visible.
- Pesticides should not be stored in old bottles or food containers where they could be mistaken for food or drink.
- Pesticides should not be stored near food, feed, or seed.
- Pesticides should be stored in tightly sealed containers and checked periodically for leakage, corrosion breaks, tears, and other signs of container deterioration.
- Pesticides should be stored in a separate building that is well ventilated and well lighted. The building should be locked when not in use to prevent access by unauthorized personnel.
- Some pesticides should not be stored together. This is especially true of the hormonal herbicides, which should not be stored with insecticides or fungicides; they are volatile and may cross-contaminate one another.
- An up-to-date inventory should be kept on all stored pesticides.

TRANSPORTING PESTICIDES

Pesticides can present a particularly severe hazard if they are involved in accidents during transportation. When pesticides are spilled on the roadway, they may catch fire, be scattered by passing cars and trucks, be blown by wind onto nearby crops or people, or be washed into ditches or streams by rain. If they catch fire, the fumes and smoke may injure firefighters and police, and may be potentially dangerous to other persons far removed from the scene of the accident. Less spectacularly, pesticides may simply contaminate the vehicle, cargo, or personnel transporting the chemicals. The person transporting pesticides is legally responsible for their safe movement. Taking the following precautions will help prevent accidents.

- The safest way to transport pesticides is in the cargo compartment of a truck. They should not be transported in the passenger compartment of a vehicle.
- No personnel should ride in the back of a truck with pesticides; a spill could cause severe injury or death.
- Pesticides should not be transported in the same compartment with food or clothing.
- All containers should be tied down to prevent breakage and spillage; paper or cardboard containers should be kept dry.
- If any pesticide is spilled in or from the truck, it should be cleaned up at once. (See Cleanup procedures in Chapter 5.)
- Unlocked pesticides should not be left unattended.

HANDLING PESTICIDES

The hazard of personnel contamination from pesticides varies with the type of potential exposure. While the Forest Service has a good pesticide safety record, there is always a potential for accidental poisoning. Each year many pesticide applicators and others become ill from the toxic effects of pesticides. People

who handle pesticides during loading or mixing may become contaminated with the pesticide in its most dangerous form—the concentrated material. Those who apply diluted material during ground applications are less likely to be exposed to the concentrated material unless they are involved in mixing. Flaggers usually do not handle pesticides, yet they may be accidentally contaminated during aerial applications; occupational illnesses among these workers are reported with some frequency. Finally, aerial applicators themselves may become contaminated, especially if they load their own aircraft and do not use a closed pesticide-transfer system. Forest Service policy prohibits pilots from mixing and loading pesticides to reduce the possibility of pesticide contamination.

Illness resulting from pesticide application generally occurs because of skin, eye, or lung contamination. For personnel safety, various devices should be used — and are often required by label directions and regulations — when mixing, loading, or applying pesticides. But remember, while use of protective devices offers some protection against exposure, they do not eliminate the necessity for other essential precautions.

Minimum Protective Clothing

Personnel handling pesticides should wear a hard hat with a clean sweatband and coveralls over a long sleeve shirt and full length pants. They should not haul pesticides, place them in storage, or clean or dispose of empty pesticide containers without wearing the proper protective equipment. Also, when cleaning equipment contaminated with pesticides, cleaning up after a spill, or repairing contaminated equipment, they should wear and use the proper safety equipment and wear the proper protective clothing.

The pesticide label will specify the kind of protection needed for the manner in which it will be applied; general guidelines, however, are given in Table 3-1 (page 20).

Types of Protective Clothing.

Skin contamination is the leading cause of pesticide illness. Coveralls, aprons, spray suits, gloves, hats, boots, goggles, and face shields are designed to protect pesticide users from getting pesticide on their skin or into their eyes. Persons handling pesticides should always wear clean protective clothing as shown in figure 3-1.

Fig. 3-1

Coveralls. There are two types of coveralls: Disposable and reusable. Disposable coveralls are lightweight and reasonably comfortable in hot weather; they offer good protection if they are not damaged. They should always be worn when handling Categories I and II pesticides. Reusable coveralls are made of washable fabric and may be reused many times. They provide adequate protection from all but the most highly toxic and concentrated pesticides (Category I).

Aprons. Coveralls protect clothes and are usually adequate protection after the pesticide has been diluted. Persons handling concentrated pesticides, however, will also need to wear a rubber or synthetic liquid-proof apron. The apron, which should cover the body from chest to boots, will protect the front of the body from spills or splashes of the concentrate. Aprons that resist solvents used in formulating pesticides are the preferred type.

Spray Suits. When ground spraying a Category I or II pesticide, the label may require the applicator to wear liquid-proof clothing, such as rainsuits that completely cover the work clothes and are made of tear-resistant plastic. Because spray suits tend to become hot in warm weather, applications should be completed when temperatures are low enough so that those wearing the suits will be able to work safely and comfortably.

Gloves. The skin on the hands can absorb pesticides and their solvents; hands should be protected by liquid-proof gloves. Unlined flexible plastic or neoprene gloves are best for most pesticides, although natural rubber* gloves may be used when handling organophosphorous or carbamate pesticides.

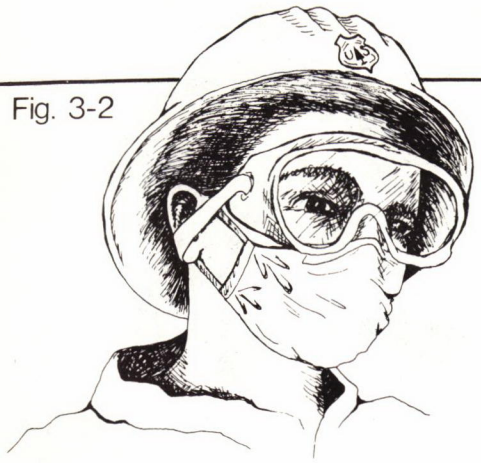
*Some pesticide chemicals are either capable of penetrating rubber or highly destructive to rubber. They include methyl isothiocyanate, a fumigant, and pantachlorophenol (PCP), a wood preservative; they should be used with extreme caution. Label instructions should be followed carefully.

Table 3-1:
Protective Clothing and Equipment Guidelines

	Mixing & Loading		Application	
	Toxicity Category		Toxicity Category	
Summarized Label Statement	I-II	III	I-II	III
Precautions necessary to prevent exposure should be taken.	A B C F G H R	B C F G H	B C G H R	C H
Protective clothing or protective equipment is to be worn or utilized.	A B C F G H R	B C F G H	B C G H R	C H R
Clean clothing is to be worn.	C	C	C	C
Contact with clothing should be avoided.	A B C	B C	B C	C
Contact with shoes should be avoided.	B	B	B	B
Rubber boots or rubber foot coverings are to be worn.	B	B	B	B
Skin contact may be harmful, fatal, irritating, damaging or poisonous.	A B C F G H R	B C F G H	B C G H R	C H
Contact with skin should be avoided.	A B C F G H	A B C G H	B C G H	C G H
Material is readily abosrbed through skin.	A B C F G H	A B C F G H	B C F G H	C F G H
A cap or hat is to be worn.	H	H	H	H
An apron is to be worn.	A	A		
Rubber gloves are to be worn.	G	G	G	G
Eye contact may be harmful, fatal, irritating, damaging or poisonous.	F	F	F	F
Eye contact should be avoided.	F	F	F	F
Material is readily absorbed through the eyes.	F	F	F	F
Goggles or faceshield are to be worn.	F	F	F	F
Breathing or inhalation of dust or mist or vapor may be harmful, fatal, irritating, damaging or poisonous.	R	R	R	R
Inhalation, breathing or nose contact should be avoided.	R	R	R	R
A respirator is to be worn.	R	R	R	R

Code	Protective Clothing and Equipment Requirements
A	Apron (liquids only)—rubber or synthetic, waterproof.
B	Boots—rubber or synthetic, waterproof.
C	Coveralls or clean outer clothing; rainsuit if will be wet with the spray.
F	Faceshield or goggles—faceshield when handling liquid, goggles when handling dust, wettable powder, or granule.
G	Gloves—rubber or synthetic, waterproof.
H	Hat—waterproof, washable hard hat.
R	Respirator; however, if the label specifies that a canister-type gas mask is needed, a respirator is not adequate.

Fig. 3-2



The gloves should be made of a material that will resist solvents, as well as pesticides; the pesticide label may specify the type. Gloves that have a cloth lining, wristband, or are made of leather should not be used. These materials soak up pesticides, are very difficult to clean, and may become the source of chronic exposure. (If it is not possible to obtain unlined gloves, the lined ones may be used but should be discarded immediately after use.)

Before using, a pair of gloves should be checked for leaks by filling each glove with water and squeezing. Should any water leak out, even from tiny pin holes, the gloves should be discarded.

Sleeves should be worn outside the gloves. This will prevent spills and splashes from running into the gloves and onto the hands.

Hats. Ordinary felt or straw hats with leather sweatbands are dangerous when worn around pesticide operations; they may absorb chemicals and lead to chronic exposures. Even small amounts of moderately or slightly toxic pesticides may cause severe skin irritations or other illness if exposure continues for several days.

Hats should be liquid-proof, preferably made of washable plastic. It may be a metal hat or it may be made of flexible plastic; in either case it should have a plastic or disposable sweatband that can be discarded after using pesticides.

Boots. When loading, mixing, or spraying large amounts of pesticides of any category or when mixing or loading any amount of Categories I or II pesticides, personnel should wear liquid-proof, unlined neoprene boots. Some fumigants, however, are readily absorbed by neoprene and the label instructions may call for special precautions or another type of footwear. While neoprene boots are available in a variety of styles, knee-length boots offer greater protection because they extend above the lower hem of the apron. Leather or fabric boots should not be worn because they will absorb pesticides and cannot be cleaned effectively.

Pant legs should be worn outside of the boots. This will reduce the chance of spills and splashes running into the boots and onto the legs and feet.

As with gloves, if it is not possible to find unlined boots, lined ones may be used, provided they are thrown away afterward and not reused.

Care of clothing. Contaminated clothing is a major source of human exposure to pesticides. Clean clothing should be worn daily. If clothes get wet with diluted pesticides, they should be changed immediately. If they get wet with pesticide concentrates or highly toxic pesticides, normal washing methods will not get them clean; they should be destroyed in a safe manner.

Types of Eye, Mouth and Face Protection

Protecting the face, mouth, and eyes from pesticide sprays and splashes is good common sense when handling any pesticides; it is required when mixing, loading, or applying Categories I and II pesticides.

Goggles. It is especially important that the eyes be protected by goggles when handling dusts, wettable powders, or granules. Goggles are manufactured so that they offer effective eye protection, yet are non-fogging. Many will fit over ordinary eyeglasses. (See figure 3-2.)

Some goggles, however, have a headband that is made of material that readily absorbs chemicals. The headband on this type of goggles should be replaced with one made of non-absorbent material or replaced after each use.

Fig. 3-3

Fig. 3-4

Surgical masks. Surgical masks are occasionally worn when mixing or using low-toxicity or inert dusts, such as diatomite, to prevent allergic reactions.

Face shields. Goggles offer eye protection, but frequently full face protection is better. Splashes are common during mixing and loading of pesticides. It is, therefore, important that the face as well as the eyes are protected during the pouring or mixing of highly toxic liquid concentrates. The best face shields are made of clear plastic; they attach to a hard hat and can be raised or lowered as needed. (See figure 3-3.)

Types of Respiratory Devices.

A respiratory device is one of the most important pieces of pesticide safety equipment. The two kinds of personal respiratory devices in general use are chemical cartridge respirators and canister-type gas masks. Specific types of cartridges and canisters protect against specific chemical gases and vapors. The label will specify which to use for the particular pesticide. Only those approved by the National Institute for Occupational Safety and Health (NIOSH), or the Mining Enforcement and Safety Administration (MESA) should be used.

The respirator must fit the face well. Long sideburns, a beard, or glasses may prevent a good seal. The manufacturer's instructions on the use and care of any respirator and its parts should be read carefully before the respirator is used.

Personnel who are handling pesticides should change filters, cartridges, and canisters if they have trouble breathing or smell pesticides. Filters, cartridges, and canisters should be removed and discarded after use. The face piece should be washed with detergent and water, rinsed, dried with a clean cloth, and stored in a clean, dry place away from pesticides.

Chemical cartridge respirators. Most chemical-cartridge respirators are designed as half-face masks, covering the nose and mouth, but not protecting the eyes. They are designed for use where high concentrations of pesticides are unlikely, for example, when mixing or loading pesticides outdoors with adequate ventilation. They have one or two cartridges attached to the face piece. They are usually equipped with one-way valves that forces inhaled air through the cartridges. There is a separate exhalation valve. (See figure 3-4.)

The cartridges usually contain an absorbing material, such as activated charcoal, and a filter pad to remove dust and spray particles. The effective life of the cartridges varies according to the concentrations of pesticides encountered, and the humidity, temperature, and the volume of breathing by the user. The devices will gradually lose their effectiveness during storage.

Gas masks. Gas masks usually cover the eyes as well as the nose and mouth. The face piece of a gas mask may contain a canister of filtering material or it may be connected by a flexible hose to a canister designed to be worn on a belt. While their operation is similar to that of chemical-cartridge respirators, gas masks always contain more absorbent materials in their canisters and have a longer life than respirator cartridges. (See figure 3-5).

Self-contained breathing apparatus. Self-contained breathing apparatuses should always be used when working with high

Fig. 3-5

Fig. 3-6

concentrations of Categories I and II pesticides. These respiratory devices do not use filtered air from the surrounding environment. Rather, they are equipped with a cylinder of compressed air that is usually carried on the user's back. The respirators are especially designed for fumigant work and for applying toxic gases in enclosed spaces. They are also particularly useful in emergency situations, such as spills, fires, and fumigant leaks. In general, they contain enough air to sustain a person for 30 to 45 minutes. (See figure 3-6.)

Hooded respirators. These devices cover the head and shoulders. Usually they are supplied with filtered air blown through the hood by a motorized fan; they may be powered by a portable battery or a plug-in electrical system. Some hooded respirators are air-conditioned for hot weather use.

Because of their superior protective capacity, supplied-air respirators or gas masks —not cartridge-type respirators—must be worn by personnel exposed directly to concentrated sprays or dusts, as in greenhouse applications. For special operations, such as dusting or spraying a greenhouse on hot calm days, full-face gas masks will suffice.

MIXING AND LOADING PESTICIDES

The most dangerous pesticide-use job is pouring and mixing the concentrated chemicals. If personnel observe a few common sense rules, they will make mixing and loading safer. The rules are:

- Read the safety information on the pesticide label.
- Put on the correct protective clothing and other necessary protective equipment specified on the label. If there are questions concerning the protective equipment, contact the appropriate Forest Service pesticide coordinator before opening the container.
- Keep first aid equipment and a good supply of clean water readily available.
- When mixing pesticides, measure carefully. Use only the amount called for on the label. Mix only the amount needed.
- Do not work alone; use the "buddy system."
- Mix the pesticides outdoors, in a place where there is good ventilation and light.
- Stand upwind of the pesticide to avoid contamininating yourself; advise others and be sure all personnel are upwind of the mixing site.
- Use a sharp knife to open paper bags; do not tear them.
- When removing concentrated material from the container, keep the container below eye level to avoid splashing or spilling any pesticide on the face or into the eyes.
- If pesticides are splashed or spilled while mixing or loading, stop immediately. Remove the contaminated clothing. Wash the skin thoroughly with detergent and water. Speed is essential. Once clean, put on clean protective clothing and equipment and clean up the spill.
- Replace caps and close all containers after use.
- Keep stirring paddles, measuring cans, and other loading equipment clean and stowed away when not in use.
- Do not leave chemicals and loading equipment unguarded or insecurely stored if operations are temporarily discontinued.
- Do not eat or smoke around mixing equipment.

Chapter 4:

Safety During Application

Pesticides are in some cases prepared by the manufacturer in a form that allows their direct application to the target site. For example, gopher baits can simply be poured out of the box or bag. Most pesticides, however, are formulated in such a manner that they require specialized equipment for application. The application equipment may be as simple as a squirt bottle or it may be as complex as a helicopter with pressurized spray equipment. In any case, successful, efficient, and safe application of any pesticide requires that the right equipment for the job be properly maintained and used correctly by trained personnel.

Most pesticides are formulated so that they must be mixed with a diluent — water or oil — before applying them. Because most water-pesticide mixes are applied as sprays, a number of spray devices have been developed. These devices range from simple hand and back-pack sprayers to complicated and powerful air-blast units capable of holding hundreds of gallons of solution. Each device has its uses and limitations. This discussion of pesticide application equipment includes listings of equipment and pesticide safety considerations for their use.

APPLICATION DEVICES

The type of application device to be used for a specific job will depend on a number of things — the area to be treated, its location and access, and the pest to be controlled. Generally speaking, however, there are two basic types of application equipment, unpowered and powered.

Unpowered Applicators

Unpowered applicators usually consist of small metal containers that hold a few gallons of solution or pounds of dust or granules. If the pesticide is a spray it is usually added to the container, diluted with water, and the unit pressurized by pumping air into the container. Other types of hand sprayers are aerosol bombs and granular applicators. Hand applicators are generally used to apply pesticides in structures, such as greenhouses, and other areas where powered units are too large to be used.

Power Applicators

Power applicators are used for rapid application of pesticides to large areas. With power equipment the pesticide can be sprayed over many acres in a day's time, be blown to the tops of tall trees, or forced into confined spaces.

Most power sprayers are designed to apply diluted pesticides. The concentrate is mixed with a solvent, usually water, and pumped from a storage tank through distribution lines to one or more nozzles that control the size and distribution of the spray droplets.

There are many kinds of power application equipment, including foggers and aerosol generators, dusters, granule spreaders, low pressure boom sprayers, high pressure sprayers, air blast sprayers, low volume and ultra low volume concentrate sprayers, and aircraft.

Foggers and aerosol generators. These break the pesticide formulation into very small droplets. The large number of particles are visible as a cloud or fog. The fog may be created by atomizing or high pressure nozzles, spinning disks, or by a heated element called a thermal generator. Their main safety disadvantages are little residual control and even light wind may cause long distance drift and unwanted contamination.

Dusters. These applicators blow fine particles of the pesticide dust onto the target. Safety problems revolve mostly around the fact that dusts are highly subject to drift.

Granule applicators. These devices are designed to apply coarse, dry particles to the soil. Granular applicators offer no special safety hazards.

Low pressure room sprayers. These sprayers are usually mounted on tractors, trucks, or trailers. They are designed to deliver

10 to 40 gallons per acre of pesticide at 30 to 60 pounds per square inch pressure.

Ultra low volume sprayers. These sprayers apply the chemical concentrate directly without the use of water or other solvent. Safety disadvantages include increased risk to the operator and crew from handling and spraying the pesticide concentrate.

High pressure sprayers. These are often called "hydraulic sprayers." They deliver large volumes of spray at pressures up to several hundred pounds per square inch. While high pressure sprayers are more versatile than low pressure units, there is a tendency for the spray to form small droplets and drift, creating a potential safety hazard.

Air blast sprayers. These units use a high speed, fan-driven air stream to dispense the spray. A series of nozzles inject the spray into the air stream which breaks up and blows the droplets. They can deliver either high or low volumes of spray. Safety concerns require that air blast sprayers be used only in calm weather; the sprayers produce small droplets that may pose a drift hazard to personnel.

Low volume air sprayers. These sprayers, sometimes called mist blowers, operate similarly to air blast sprayers, except with lower water volumes. The type of sprayer depends on a metering device that operates at low pressures and uses high speed air to break up the liquid. Favorable spraying weather is essential for their use.

Components of Power Applicators

Tanks. The tank of a power sprayer holds the pesticide and diluting solvent. The tank also generally contains some sort of agitator to keep insoluble formulations—such as wettable powders—in suspension. While tanks may be made of of almost any material, those made of corrosion and rust resistant materials should be used. The tank should have a large opening for easy filling and cleaning; an accurate sight gauge for determining the degree to which it is full; a tight fitting cover to prevent spills or splashes, and a bottom drain so that the tank can be emptied completely during cleanup.

Agitators. Without agitation, some pesticide formulations will settle to the bottom of the tank, clog lines, cake up, and change the concentration of pesticide in the spray. Agitation prevents this and is accomplished by hydraulic or mechanical means. In hydraulic agitation, some of the solution is simply pumped back through the tank, sometimes with a special high-pressure pump.

Mechanical agitators generally consist of a paddle or propeller suspended in the spray tank.

Pumps. There are many types of pumps available for pesticide application equipment, each with its advantages and disadvantages. There are two safety considerations regarding pumps: First, the pump must be able to produce the correct operating pressure at the capacity required for the particular pesticide formulation; second, the pump—and especially its non-metal parts, such as gaskets—must be able to withstand the chemical action of the pesticide without excessive corrosion or development of leaks.

Nozzles. Nozzles help control the rate, droplet size, uniformity, thoroughness, and safety of pesticide applications. Maintaining effective nozzle performance is crucial; they must be cleaned, kept in good repair, and properly adjusted to ensure that pesticides are placed where, and only where, needed. Misplaced pesticide is a potential safety hazard.

EQUIPMENT CHECKOUT

To prevent spillage of chemicals, all application equipment should be checked routinely for:

- Leaking hoses, pumps, and connections.
- Plugged, worn, or dripping nozzles.

Sprayers should be cleaned and flushed before they are used. New sprayers may contain metallic chips or other foreign objects from the manufacturing process. Sprayers that have been idle for a time may contain bits of rust. Failure to thoroughly clean such equipment may result in clogged sprayers,

increasing opportunities for undue exposure. Rubber gloves should be worn when removing the nozzles and screens and flushing the sprayer.

CALIBRATING APPLICATION EQUIPMENT

It is important to calibrate application equipment so that the correct amount of pesticide is applied; a safety hazard can be created by applying too much chemical. Also, calibration provides a final check on the operation of the equipment.*

LOADING PESTICIDES INTO TANKS

Before personnel prepare a spray mixture, they should review the label on the container, calculate the requirements, and plan how to carry out the mixing and loading safely

When the pesticide can be pre-mixed and held temporarily in storage tanks, it should be pumped directly into the sprayer tank. Care must be taken to avoid splashing and spillage. Meters equipped with pre-set stops can be used for safety and speed of loading.

When the sprayer tank is used to mix the pesticide concentrate with water or other liquid, the pesticide should be added when the tank is nearly full unless the label specifies otherwise. The containers should be opened carefully to avoid spillage of liquid or dispersion of dust. The pesticide should be introduced by keeping the opening of the container near the surface of the liquid and allowing the concentrate to slide into the mix. While doing this, the operator should stand with his back to the wind.

When using wettable powders, the required amount of powder should be stirred into a 5-gallon bucket containing a sufficient amount of liquid to make a smooth mixture. This may then be poured into the sprayer tank. The bucket should be only 3/4 full to reduce the tendency to slop over during transfer.

SPECIAL PROCEDURES FOR AERIAL APPLICATION

Airstrips

Because many outlying airstrips are infrequently used, they should be dragged before they are used. If they are near roads or highways, caution signs should be posted to warn motorists of low flying air traffic.

When working off of unimproved airstrips in dusty conditions, care should be used in moving planes and equipment up to the mixing area to keep dust out of the equipment and engines. When two or more planes are working out of such strips, one should stay in the air while the other is loading, unless there are to be extremely long delays.

Personnel who work in the vicinity of a helicopter should be instructed to:

- Stay away from tail rotor at all times and see that others do likewise.
- Wear headgear with fastened chin strap so it will not blow off.

Unless authorized by the pilot, personnel should stay away from the helicopter when rotor blades are in motion. Safe distances are at least 50 feet from small helicopters and 100 feet from large helicopters. If personnel must approach within 50 feet of the helicopter, they should approach from the front and within view of the pilot. They should not approach or leave the helicopter from any side where the ground is higher than the ground where the craft is standing.

Unless wearing safety goggles or glasses, personnel should not watch helicopter landings, takeoffs, or hovering from closer than 100 feet.

Personnel who fly in a helicopter should wear fire-retardant clothing, a shoulder harness, seat belt, and hard hat or crash helmet with the chin strap fastened; they should keep their safety belt fastened until the aircraft has landed and they are instructed by pilot to leave the aircraft. They should not stand up in open

*Directions for proper calibration methods are given in J. Barry and P. Kenney, "Calibration of Aerial Spray Systems." USDA. 1981

cockpit helicopters.

Overdue aircraft and malfunctioning equipment or aircraft should be reported to the Project Officer immediately.

The base station should be kept informed as to the location of the helicopter. When inter-district moves are made, the receiving District should be informed as to the expected time and place of arrival of the helicopter and should inform the sending District of the arrival time of the helicopter when the move has been completed.

Fatigue and Poisoning

All personnel who are working with pesticides should be monitored for signs of fatigue and poisoning at regular intervals. After long hours of heavy work, fatigue can result in increased risk. The pressure of getting the job done should never take precedence over relaxation and rest when workers become tired.

Monitoring for symptoms of pesticide poisoning should also be done at regular intervals during the work day; the sooner symptoms are detected, the less serious the incident is likely to be. Chapter 7 discusses specific symptoms of pesticide poisoning.

Chapter 5:

Cleanup

In cleaning up, personnel should dispose of any waste materials first, then clean up the equipment and the work areas, and finally, thoroughly wash themselves.

GENERAL CLEANUP

Cleaning solutions differ for washing various pesticide residues from clothing and equipment, even for pesticides that are members of the same chemical group. In some cases, for example, either soap or detergent solutions may be used, while in other cases only one or the other should be used. Occasionally, neither soap nor detergent should be used, but rather a solution of acetic acid, soda, or some other cleansing agent is preferred. The manufacturer of the pesticide, or the manufacturer's distributor, can advise on the appropriate cleansing agent and the proper solution of the agent in water for the particular pesticide. This information usually will be found on the label.*

Following, however, are general guidelines for cleaning up equipment after mixing, loading, and applying specific chemical groups of pesticides.

Organophosphates

Organophosphate contaminated equipment should be washed with a solution of soap and water; detergents are not recommended. Several soap-solution washings will decompose organophosphorus compounds, and remove them from most surfaces. The surfaces should then be rinsed with clean water. (Any spills that occur should be covered immediately with lime and left to stand for several hours.)

Chlorinated Hydrocarbons

When endrin has been used, decontamination may be carried out by washing with water to which acetic acid (vinegar) has been added. Soap should not be used. When methoxychlor has been used, soap and water may be used for decontamination.

Carbamates

Equipment that is contaminated with carbamates should be washed thoroughly with a washing soda solution or a soap solution, and rinsed with clean water.

DISPOSAL OF WASTES

Waste pesticides should be considered hazardous to the public and to people handling them. Improperly handled, these materials are also potential pollutants of the environment. Containers are a major secondary hazard. Projects should be planned so that very little pesticide is excess.

Deciding how to dispose of pesticide wastes should be done on a case-by-case basis, in accordance with State and local regulations. Consult the manufacturer, if possible, for special instructions regarding specific products.

Disposal of Pesticide Containers

Disposing of pesticide containers is a significant problem, particularly if a large area has been treated and a large number of containers has piled up.

Before disposing of any metal or glass pesticide container, it should be rinsed with water or other solvent used in mixing the pesticide for application. The procedure is as follows:

- Completely empty the container into the mixing tank. Allow the container to drain for a few minutes.
- Fill the container about one-fourth full of water or solvent.
- Close the container, rotate or shake it so that the water sloshes around and rinses all interior surfaces.
- Drain the liquid from the container into the mixing tank. Allow the container to drain for a few minutes.
- Rinse two more times. Empty each rinse into the mixing tank; then fill the mixing tank to proper level.

Even after rinsing, the washed container still contains some pesticide and is not safe for any

*A current authoritative source for cleanup solution recommendations is "Guidelines for Disposal of Small Quantities of Unused Pesticides." EPA Technical Series 670/2-75-057. U.S. Environmental Protection Agency. Cincinnati. 1975.

other use. Other pesticides should not be put into empty containers. All containers should be discarded after one use or returned to the manufacture or distributor.

Group I containers. These are containers that will burn and held organic or metallo-organic pesticides (but not organic mercury, lead, cadmium, or arsenic compounds). They can be disposed of by burning in a special pesticide incinerator; burying in a specially designated landfill, if available, or by burning in small numbers, as directed by State and local regulations; or by burying singly in open fields, at least 18 inches deep.

Group II containers. These are containers that will not burn and held organic or metallo-organic pesticides (but not organic mercury, lead, cadmium, or arsenic compounds). Many large containers in this group that are in good shape can be reused by the supplier, and can be returned to the pesticide manufacturer or distributor.

If they are rinsed out well they may be recycled as scrap metal, crushed and buried in a sanitary landfill, or buried in a field using the same precautions as for Group I containers. If the containers cannot be rinsed, they should be buried in a specially designated landfill.

Group III containers. These include any containers that held organic mercury, lead, cadmium, or arsenic, or inorganic pesticides. They can be rinsed three times, crushed, and buried in a sanitary landfill or, if they cannot be rinsed, they can be buried in a specially designated landfill.

Disposal of Unused and Excess Pesticides

Disposing of unused and excess pesticides can be a critical problem, depending on the amount of unwanted chemical. At present there is no simple solution to this problem. Local authorities, including County Farm Extension Specialists or regional U.S. Environmental Protection Agency offices, should be consulted for recommended disposal procedures for each specific project area.

In general, however, they can be either burned in a specially designed pesticide incinerator or buried in a specially designated landfill. If they cannot be burned or buried right away, they should be stored until they can be. The best precaution against pesticide disposal problems, of course, is good planning, which begins with mixing the right amount of pesticide in the first place.

EQUIPMENT CLEANUP

After completion of a pesticide application, the mixing, loading, and application equipment should be cleaned immediately inside and out. The cleaning operation can be hazardous if proper precautions are not taken. Personnel who clean the equipment must know the correct procedures and wear the appropriate protective clothing—including rubber or synthetic boots, goggles, apron, and gloves. The actual cleaning should be done in a specific area, preferably on a wash rack or cement apron that has a well-designed sump to catch all contaminated wash water and waste pesticides for later disposal.

In some cases equipment may need to be steam cleaned or special cleaning agents may be required; in most cases, however, hot water and detergent will be enough. Personnel cleaning the equipment should wear rubber gloves and other protective clothing as appropriate; they may come into contact with pesticide material.

Water used for cleanup should look clean enough to drink. A small amount of silt or sand particles can rapidly wear pumps and other parts of the sprayer system. Water pumped from ponds or stock tanks should be filtered before filling the tank. **To avoid contamination of water supplies, the application equipment should be equipped with an air-gap separation or back-flow prevention device to prevent pesticides from being siphoned back into the water source.**

A sprayer system usually has screens in three places: A coarse screen on the suction hose; a medium screen between the pump and the boom; and a fine screen in the nozzle. The

nozzle screen should be fine enough to filter particles that will plug the tip orifice. These screens must be kept in place.

Metal objects should not be used to clean nozzles. Rather, the tips and screens should be removed and cleaned with a soft brush in water or a detergent solution. The orifice in a nozzle tip is a precision machined opening. Cleaning with a pin, knife, or other metallic object can adversely change the spray pattern and capacity of the tip: if no brush is available, a round wooden toothpick may be used.

After each day's use, the sprayer should be thoroughly flushed with water, inside and out, and the pump operated to clear lines and nozzles and to prevent corrosion.

The cleaning water discharge should not be allowed to contaminate water supplies, streams, crops, or other plants, or to puddle where it will be accessible to children, pets, livestock, or wildlife.

Corrosiveness

Some pesticide chemicals are corrosive to metals; special care such as additional rinsing, should be taken during cleanup when they have been used.

Mildly corrosive pesticides. These chemicals include: Cacodylic acid, dicamba, DSMA, glyphosate, malathion, and MSMA.

Highly corrosive pesticides. These chemicals include: Amitrole, ammonium sulphamate, paraquat, and phosphamidon.

LOADING AND MIXING AREAS

To keep spillage and waste to a minimum, a clean and well equipped loading area is essential. All spills should be cleaned up at once.

Suitable receptacles—such as open-head 55 gallon drums—should be conspicuously painted and used for the collection of spilled materials and empty chemical containers. These waste bins should be emptied daily, or kept in the pesticides storage building overnight.

Spilled dry materials should be swept into plastic bags, which are then tied closed before disposal.

Spilled liquids should be absorbed by coarse clay or sawdust, which is then swept into plastic bags for disposal. Proprietary absorbants are also available. In the case of organophosphate compounds, the area should be cordoned off and lime should be spread over the spill and left for several hours before collection.

An industrial vacuum cleaner may be used, if electrical power is available; its contents should be emptied into a plastic bag after each use.

A spill should not be hosed down, as the chemical may enter bodies of water or streams through leaching—with the resultant hazard to water supplies, fish, and wildlife.

PERSONAL CLEANUP

Protective equipment should be thoroughly washed and dried after the pesticide application is completed, the excess material disposed of, and the application equipment cleaned.

Next, work clothes should be removed and placed in a designated, separate area. The pesticides on clothing may harm other people who touch it. When undressing, personnel should use the buddy system if possible—that is, help one another shed outer protective clothing, leaving gloves until last so that they won't contaminate their hands from their outer clothing. Gloves can be removed by peeling them back, like taking off a stocking.

Once undressed, personnel should take a shower, washing head to foot - including hair and fingernails—with soap and water. After showering, they should put on a complete change of clean underwear and outer clothing.

Clean rubber gloves should be worn to place contaminated clothing in a plastic bag for laundering.

Chapter 6:

Responding To Accidents

The types of accidents that are most likely to occur during a pesticide application project are pesticide spills and fires, and vehicle and aircraft crashes. To respond to such accidents in a timely fashion, project personnel will need to have available the following: Shovels, sand or other neutral absorbing material, access to lots of clean water, fire extinguishers that are approved for Class B (chemical) fires, and strong soap or detergent.

PESTICIDE SPILLS AND FIRES

In spite of the most careful use and handling of pesticides, accidental spills and fires occasionally occur. Intelligent planning, knowledge of the chemicals involved, and calm consideration of the actual hazards to be dealt with during the emergency will reduce the safety risk and damage resulting from the accident.

Spills

When a spill occurs, it should be cleaned up as quickly and safely as possible. After cleanup is completed, the affected area should be immediately decontaminated. A few general rules apply to all pesticide decontamination situations.

Pesticide exposure. If any pesticide is spilled, the area should be cordoned off immediately so that no one is exposed or contaminated by accidentally walking into the spill or breathing the fumes. Personnel working with the spill should wear protective clothing so that they do not contaminate themselves.

Reporting the spill. The project officer should be notified of the spill as soon as practical.

Stopping pesticide spreading. A barrier of soil, sawdust, old newspapers, contaminated clothing—anything that will soak up the pesticide—should be built around the spill.

Removing contaminated material. If the spill is inside a building, liquid pesticides should be soaked up and powders swept up and taken outside as soon as possible. The area should be ventilated immediately.

Decontaminating the area. The label includes specific disposal and decontamination instructions. Many pesticides can be detoxified, however, by washing with water mixed with chlorine bleach and detergent. The wash solution should be kept from spreading and contaminating a larger area.

If personnel find that the cleanup job is too big for them to handle or they are not sure of how to handle it, they should keep people away, give first aid if necessary, confine the spill, and then call the manufacturer for help. The manufacturer's emergency telephone number is on the label. If, for some reason, they are unable to reach the manufacturer, they should call the National Agricultural Chemicals Association (NACA). NACA has a Pesticide Safety Team Network that can explain what to do or, if necessary, can send a safety team to help clean up the spill. NACA can be reached toll-free any time at (800) 424-9300.

Public areas. If the pesticide is spilled on a public area, such as a highway, the police, sheriff's office, fire department, the highway patrol, or other local emergency services agency should be notified. Before emergency personnel arrive, however, others should be prevented from being exposed to the pesticide by not allowing anyone to drive or walk through the spilled material. When emergency services personnel arrive, they should be told about the nature of the chemical. Most police and fire fighters will know something about chemicals, but they may not appreciate the degree of hazard.

All major spills must be reported by telephone to the appropriate State pesticide regulatory agency. Following are telephone numbers that should be available to personnel for reporting spills.

- If the spill is on a State highway, the highway patrol, or State highway department.

- If the spill is on a county road or a city street, the county sheriff, city police, or county agricultural authority.
- If food is contaminated, the State food and drug authorities, or the city, county, or State health officials.
- If water is contaminated, the State health officials; regional, State, or Federal water quality or water pollution authorities, and the State fish and game agency.

Fires

When pesticides are involved in fires, they create special hazards. Anyone in the vicinity of the fire can be exposed to toxic fumes, poisonous runoff, and concentrated pesticides from leaking or exploding storage containers. Here are some general rules that apply to pesticide fires.

Before a fire occurs. The local fire department should be told what is being stored and where it is being stored. They should be given any information they may request concerning the nature of the chemicals. This may allow them to prepare for possible emergencies and may save lives and property.

Foam or carbon dioxide. Foam or carbon dioxide—not water—should be used to fight pesticide fires (Class B fire extinguisher). If water is all that is available, it should be applied with a fogging nozzle, not in a straight stream; straight streams may spread the fire and scatter the pesticide.

Evacuate and isolate downwind areas. Fires attract spectators; they should be kept away from areas where they might be exposed to smoke and fumes or to runoff from the fire.

Safety equipment. Personnel fighting the fire should wear appropriate safety equipment to protect themselves against smoke, mist, spray, and runoff from the fire.

Unnecessary risks. Personnel fighting the fire should minimize the risk of exposure by attacking the fire from a safe distance on the upwind side. They should stay clear of drums, cans, or bottles that may explode during the fire.

Contain the fire. Both the fire and the pesticide should be kept from spreading. Water should be used to cool nearby pesticide containers. Vehicles and other mobile equipment should be moved away from the fire if it is safe to do so.

Dikes. Dikes should be constructed to prevent the excess water used in fighting the fire from running off and contaminating the surrounding area.

Call for help. If it is necessary to call for help to control the fire, the persons or agency called should be told that pesticides are involved. When help arrives, they should be informed again of the nature of the fire and told of any special information about the pesticide involved that will aid in fighting the fire and protecting themselves.

Cleanup after the fire is out should be carried out in the same manner as cleanup of spills outlined above.

CRASHES

If a vehicle or aircraft carrying pesticides crashes, personnel should not panic. They won't be able to think clearly or help the driver or pilot unless they are calm. There are four steps to dealing with a crash:

- First, if the pilot or driver is not seriously injured, he or she should be helped out of the wreckage and moved to a safe distance. If the pilot or driver is seriously injured or unconscious, he or she should not be moved but should be checked for strangling, choking, or bleeding. If there is severe bleeding, a pad of clean cloth should be held firmly over the cut with the part of the body that is cut raised, if possible. One person should watch the victim while another goes to the nearest telephone and calls for an ambulance and doctor.
- Second, if the wreckage is on fire, the fire should be put out with a fire extinguisher unless it is dangerous to do so.

- Third, the pilot's or driver's clothing should be checked to see if it has been splashed with pesticides. If it has, and if the victim isn't seriously injured, he should be helped to the nearest water and washed several times with soap.
- Fourth, if pilot or driver isn't seriously injured, he or she should be taken to a doctor. The doctor will need to know that the victim has been exposed to pesticides and the name of that pesticide. If the pilot or driver is seriously injured, someone should be assigned to go with the ambulance to the hospital or doctor's office to make certain they know that the victim has been exposed to pesticides and the name of that pesticide. If they should give him a shot of morphine for pain and he has organophosphate poisoning, it can kill him.

REPORTING ACCIDENTS

If an accident occurs, it should be reported immediately to a supervisor. Any of the following accidents must be reported to the regional or area Integrated Pest Management Work Group (IPMWG):

- Injury or death of person working with pesticides.
- Crashes of aircraft or vehicles carrying pesticides.
- Accidental dumping or spilling of pesticides.
- Adverse effects of pesticide use on humans, fish, birds, wildlife, farm animals, trees and crops, homes, and other components of the environment.
- Any significant episode, such as drifts off target, that may cause controversy.

Telephone or Telegraph Reports

Accidents should first be reported by telephone or telegraph to the IPMWG chairman who will advise field staff of what actions to take.

Written Reports

Telegraphed or telephoned reports must be followed by a written account, that includes the following facts:

- Name, EPA registration number, and quantity of pesticide involved in the spill.
- Location of incident (State, National Forest, county, city).
- Ownership of property involved (if private property, owner's name and address).
- Tree species, plants, animal community, or structure treated.
- Pest or pests involved.
- If humans were involved, a written statement from attending physician.
- If domestic animals were involved, a statement from attending veterinarian.
- Name of person who ordered the work (individual landowner, State, Federal Government, supervisor of cooperative Federal-State program or project, or other).
- If publicly supported, agencies involved.
- Application information (date pesticide was applied, time, method of application, applicator, formulation, and dosage; if fumigation was involved, whether area was wrapped or sealed and checked for leaks).
- Name, address, and phone number of person to contact for more information.

In addition, the report should answer the following questions:

- Was the material used registered by the Environmental Protection Agency and/or the State?
- Was the material used according to label directions? If not, how was it used?
- Did the label warnings and precautions cover the use?
- If protective devices were recommended on the label, were they used?
- Were there unusual circumstances, such as adverse weather, involved?

- If warning placards or watchment were recommended, were they used? If not, why?
- Did the public have adequate notice?
- Was an environmental assessment prepared?
- Was the owner aware of any hazard that might exist?
- Was the applicator aware of hazards that might exist?
- Was the application equipment properly calibrated and in good condition?
- Have there been recent similar incidents in the community involved? If so, explain.
- What was collected—carcass, plant material, water, soil, formulation used, other?
- Where were samples sent for analysis?
- Have results of sample analysis been obtained? If so, what were they?

Copies of any news articles pertaining to the incident should accompany the final written report.

Chapter 7:

Symptoms Of Poisoning

Pesticide poisoning incidents must be recognized immediately because prompt treatment may mean the difference between life and death.

GENERAL SYMPTOMS

General early symptoms of pesticide poisoning include fatigue, headache, dizziness or drunkenness, and nausea and vomiting. The degree to which the person has been exposed to the pesticide will determine the intensity of the symptoms and the manifestation of additional symptoms. Usually, symptoms progress—depending on the exposure and the pesticide—from mild physical distress to muscular weakness and breathing difficulty to coma and death.

CHEMICAL GROUP SYMPTOMS

Each chemical group of pesticides has its own symptoms. The symptoms result from the toxicology—or mode of action on living organisms–of the chemical group. Following are brief descriptions of the toxicology and symptoms of poisoning for the chemical groups most often used in forestry pesticide applications.

Carbamates

Included in this class of chemicals are carbaryl and carbofuran (Category III pesticides).

Toxicology. Carbamates inactivate the cholinesterase enzymes of the blood and other tissues. The symptoms of exposure are caused by stimulation of the parasympathetic autonomous nervous system and the motor nerves of the skeletal muscles.

Symptoms. Symptoms of carbamate poisoning include headache, dizziness, weakness, discoordination, restricted pupils, and involuntary muscular movements. Other symptoms associated with carbamate poisoning are mental confusion, incontinence, diarrhea, nausea, excessive salivation, vomiting and convulsions. Symptoms develop within 12 hours of exposure.

Chlorinated Hydrocarbons

Chlorinated hydrocarbons include the following pesticides: Endosulfan, lindane, and toxaphene (Category II); chlordane, and dicofol (Category III); and chlorobenzilate and methoxychlor (Category IV).

Toxicology. These chemicals interfere with the transmission of nerve impulses, affecting the brain and disrupting nervous system function. This results in sensory and equilibrium dysfunction, depressed breathing, involuntary muscle activity, and behavioral changes.

Symptoms. First symptoms usually include apprehension or excitability or both; twitching and tremors; and, if severe poisoning has occurred, convulsions. Other symptoms include dizziness, headache, disorientation and digression when speaking, and weakness.

Chlorophenoxys

Chlorophenoxy chemicals are generally on the lower end of the toxicity scale. They include: MCPA and 2,4-D.

Toxicology. Chlorophenoxys appear to have low toxic effect on most humans, although they are mildly to severely irritating to the skin, eyes, and respiratory and intestinal tissues.

Symptoms. Excessive dermal contact causes irritation and a burning sensation; excessive inhalation of vapors can cause a burning sensation of eyes, nose, and throat; coughing; discoordination; and dizziness.

Dipyridyls

Dipyridyls are used as herbicides; they include paraquat (Category I) and diquat (Category II).

Toxicology. Dipyridyl compounds bind to epithelial tissues and mucous membranes, and in sufficient dosage causes inflammation and necrosis of the tissue. In the lungs, they can

permanently impair the exchange of oxygen and carbon dioxide through damage to the tissue. Some symptoms may not appear for up to 2 weeks.

Symptoms. Skin contact results in drying, cracking, and irritation of the exposed area; discoloration of fingernails results from chronic exposure. Eye contact often results in conjunctivitis (inflammation). Inhalation irritates the nose and throat and can induce nosebleed; a cough usually develops within 14 days if a dangerous level of inhalation has occurred. Symptoms of ingestion include oral and abdominal pain, diarrhea, and vomiting.

Organophosphates

Organophosphates include azinphos-methyl (Category I); coumaphos, crotoxyphos, and diazinon (Category II); and malathion (Category III). Organophosphates are, as a class, the most toxic of pesticides.

Toxicology. Organophosphates inactivate the cholinesterase enzymes of the blood and other tissues, impair the central nervous system, and activate the parasympathetic nervous system, affecting the motor nerves of the skeletal muscles.

Symptoms. There are many symptoms of organophosphate poisoning, including: Headache, dizziness, weakness, loss of coordination, reduced pupil size, muscular twitching and tremor, incontinence, nausea, stomach cramps, diarrhea, sweating, excessive salivation, slowed heartbeat, and unconsciousness. Symptoms also include mental confusion and appearance of drunkenness.

Triazines and Substituted Ureas

These related groups of chemicals include liquid bromacil (Category II); atrazine and dry bromacil (Category III); and diuron, linuron, and simazine (Category IV).

Toxicology. The petroleum distillates with which these chemicals are usually formulated are probably more dangerous than the chemicals themselves to humans. Most reported injuries have been skin irritations resulting from prolonged contact.

Symptoms. Irritation of the eyes and mucous membranes result from prolonged contact. It is likely that symptoms of ingestion would include the general symptoms of chemical poisoning, especially nausea, diarrhea, and vomiting.

Chapter 8:

First Aid

If an accidental poisoning occurs, six steps should be taken immediately:

- *One:* Move the patient away from the pesticide and remove the patients' contaminated clothing; wash patient off.
- *Two:* Start first aid at once. If breathing is weak, give artificial respiration.
- *Three:* Call a physician; do not stop first aid.
- *Four:* Keep patient as quiet, warm, and comfortable as possible.
- *Five:* If patient has organophosphate or carbamate poisoning, *and is conscious*, give two 1/100-grain atropine tablets at once.
- *Six:* Rush patient to hospital or other medical help.

The rest of this chapter discusses general first aid procedures for accidental poisonings. First aid, however, is not a substitute for professional medical treatment; it only relieves the patient until medical help is available. Project personnel should know the first aid procedures to follow in poisoning emergencies for the specific pesticide that is used. This information can be found on the pesticide label.

ANTIDOTES FOR POISONING

Good judgment, adherence to safety practices (including the use of protective clothing and safety devices), and knowledge of the pesticide used are, in a sense, preventive antidotes — they will probably prevent poisoning incidents.

Atropine and 2-PAM

Where actual poisoning has occurred from materials such as organophosphates or carbamates, atropine is the only effective antidote. Another material, protopam chloride (2-PAM), may be used in conjunction with atropine for organophosphorus poisoning; **it must not be used, however, for carbamate insecticide poisoning.** The recommended dosage of atropine is 1 to 2 mg. injected every 15 to 30 minutes, as necessary. **Although no one but a physician should administer atropine, it is important to know that it is available if needed, before exposing personnel to these pesticides.**

Universal Antidote.

A universal antidote for ingested pesticides consists of two parts activated charcoal, one part magnesium oxide, and one part tannic acid. It is administered orally after diluting 1/2 ounce in 1/2 glass of water. Its main function is to absorb and neutralize poisons. Except in the case of ingested corrosive substances, the patient must be given an emetic to promote vomiting or the stomach must be pumped.

Universal antidotes for corrosive chemicals are as follows:

- For acid chemicals: A mixture of 1 tablespoon milk of magnesia to 1 cup water.
- For alkali chemicals: 1 quart milk.

Before beginning field work, the area Poison Control Center should be contacted and asked to prescribe the appropriate antidote for the pesticide to be used.

GENERAL FIRST AID

Persons exposed to pesticides should be instructed to remain calm. The serious effects of most pesticides are not instantaneous, so they will have some time to protect themselves. If they have been exposed to a highly toxic pesticide and are beginning to feel ill, someone should immediately take them *and the pesticide label* to the doctor. But before a victim is taken to a doctor or hospital emergency room, someone should call ahead to alert of the victim's condition and probable arrival time. The doctor should not be asked to come to the victim; equipment needed for proper treatment may not be readily moved and it will probably be quicker to move the victim.

SPECIFIC FIRST AID

There are three "first" steps that should be taken when a person is accidentally exposed to pesticides. One is to stop the exposure by separating the person from the source of exposure. Another is to administer first aid. The last is to transport the victim—with a readable label or the name of the chemical—to a doctor or hospital emergency room.

Specific First Aid Procedures

Poison on skin. If persons have pesticide on the skin, they should have their clothing removed and skin drenched with fresh water. Their skin, hair, and fingernails should be washed thoroughly with soap and water; speed in washing is most important in reducing the extent of the injury. Victims should then be dried, wrapped in a blanket, and taken for medical treatment.

Poison in eyes. If persons have pesticide in their eyes, their eyelids should be held open and their eyes washed immediately with a gentle stream of clean running water for 15 minutes or more. The wash water should be free of chemicals or drugs—they may increase the extent of injury. As soon as the eyes have been thoroughly flushed, the victim should receive medical attention.

Inhaled poisons. If the victim has inhaled pesticide in an enclosed space, he should be rescued only by a person attired in the proper respiratory equipment. The victim should be carried or dragged (not allowed to walk), to fresh air immediately. The victim's clothing should be loosened and he should be given artificial respiration if breathing has stopped or is irregular. If the victim is convulsing, his breathing should be monitored and his chin kept up so the air passage will remain free for breathing. He should not have alcohol in any form. The victim should be wrapped in a blanket to prevent chilling, kept as quiet as possible, and taken at once for medical attention.

Swallowed poisons. If a pesticide has been accidentally swallowed, a determination must be made of whether to induce vomiting or administer an antidote. If the label recommends vomiting, the victim should be forced to vomit at once unless he or she is unconscious or in convulsions.* If the label recommends an antidote, an appropriate one (see page 37) should be administered if the victim can swallow. The victim should then receive immediate medical care.

Chemical burns. If persons have received chemical burns of the skin, their contaminated clothing should be removed, their skin washed with large quantities of running water, and the burn area immediately covered with loose clean cloth. They should not be treated with ointments, greases, powders, or other drugs, but should be treated for shock by keeping them flat, warm, and reassured until they reach a doctor.

THE FIRST AID KIT

Anyone working with pesticides—especially the highly toxic ones—should have available a specially prepared first aid kit. The first aid kit may save a life; it should include the following: Plastic bottle of detergent or soap (see discussion of cleanup solutions, page 28) to wash pesticides off the skin; plastic container of salt to induce vomiting; plastic container of baking soda or bottle of milk of magnesia to neutralize acidic chemicals that have been swallowed; plastic bottle of lemon juice or vinegar to neutralize basic or alkaline chemicals that have been swallowed; bag of activated charcoal to mix with water and swallow to act as pesticide absorber; shaped plastic airway to use for mouth-to-mouth resuscitation; plastic bottle of clean water to dilute the salt, baking soda, lemon juice, and vinegar; band aids, bandages, and tape; blanket to cover a victim in shock; cups for drinking; and small change (nickels, dimes, quarters) to make emergency phone calls.

*Vomiting can be induced by placing the bowl end of a spoon at the back of the patient's throat or by having the victim drink an emetic of two tablespoons of salt in a glass of warm water. When retching and vomiting begin, the victim should be placed face down with head lowered to prevent the vomit from entering the lungs and causing further damage.

MEDICAL ATTENTION

At each work site there should be posted the name, address, and telephone number of the physician, clinic, or hospital emergency room that will provide care in the event a person is poisoned. This provider should be called the minute accidental exposure occurs and told the name of the chemical that the victim has been exposed to, the kind of exposure (oral, dermal, eye, or inhalation), the current state of the victim (ambulatory, incapacitated, unconscious), and the approximate amount of time it will take to get the victim to the provider. This will give the provider the necessary information to prepare for the victim's arrival and the time, if necessary, to check with a poison control center for the preferred treatment. A copy of the pesticide label should accompany the victim to the provider to confirm the telephoned information.

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